cHRI Training

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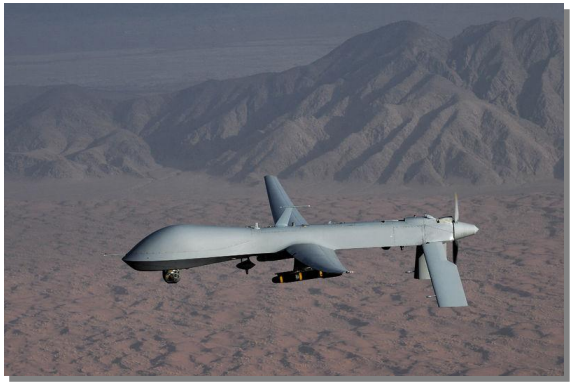
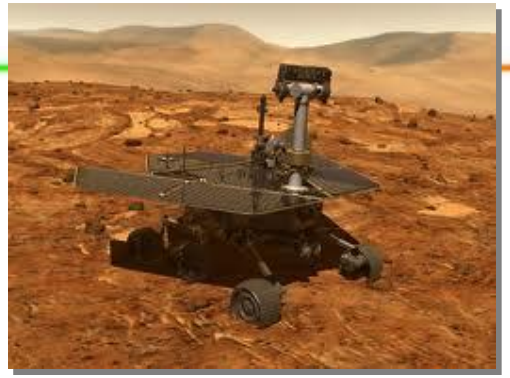
Three Laws of Robotics

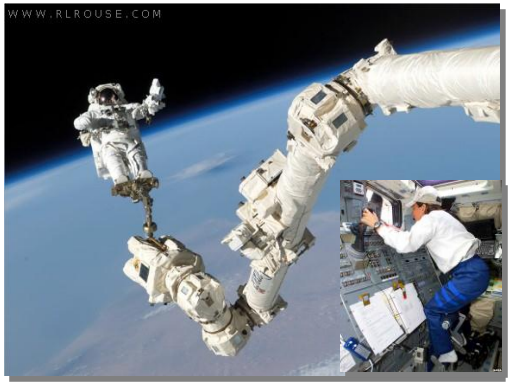
Taken from *Runaround* (1942) by Isaac Asimov

1. "A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

- Aerial
- Sea
- Ground
- Subterranean
- Inter-planetary







- *Unfolding decision environment*
- *Mixed assets that must work together and work semi-autonomously*
- *Desirable to designate a single operator to multiple UVs*

HRI Issues

- Situation awareness
- Task switching
- Change blindness
- Recovery from interruptions and distractions
- Multi-tasking
- Trust in automation (over-reliance, under-reliance) PFA
- Mental workload
- Error diagnosis
- Plan monitoring and revision/Plan continuation errors
- Concurrent task management - PM
- Loss of skills

How can training mitigate these issues?

Training Regime

- Should be based on
  - sources of automation usage errors
  - learning theory
    - Scenario-based
    - Performance feedback (extrinsic errors/appraisal)
  - human memory limitations
  - naturalistic decision making
  - attentional limitations

How you train is determined by what you want to train

- Motor response
- Perceptual detection
- Communication with robot
- Cognitive interpretation
- Prediction of what is coming next

ID Context

- Tasking environment
- Time pressure
- Fatigue
- Reliability of the system
- Information congruence
- Information accuracy
- Situation understanding
- Stress (performance consequences)
- Potential for automation bias
- Level of automation and "return to manual" performance
- Distractions

Use Training to Calibrate the Operator

- Teach how to learn
- Train limitations and capabilities
  - Own
    - Varied skills, knowledge, experience ; done with feedback during training
    - determining when to ask for help
  - Automation
    - Provide insights into the philosophy, if any, which drove the design (process and algorithms)
      - » in-depth training on automated avionics systems
      - » fallacy that since the operator can not affect these matters, they have no need to know about them
      - » higher-level strategy(s) set by the human
    - Train the past performance of the A/acc/inc hanger stories
    - Train the operator regarding its expected reliability

cont.

Use Training to Calibrate the Operator

- Train limitations and capabilities
  - Automation (continued)
    - Train the operator regarding the mechanisms governing its behavior and intended use
    - Train how to recognize that have to solve the problem on own
    - How to leverage abilities
    - Know when accurate information will be provided
    - Has robot been build to avoid hazards/to safe itself when necessary.
    - Awareness of context-related nature of robots reliability

Use Training to Calibrate the Operator

- Train how to communicate effectively
  - teach the human to use the limited subset of nomenclature (e.g., ATC) that corresponds to the robot's sensing and acting repertoire
  - human communication is fraught with ambiguity, and that the robot needs a large base of experience for reference points to predict, fill in and otherwise disambiguate the conversation.
    - Train how to
      - » Communicate a common goal
      - » convey information
      - » how to ask questions, query automation (replay tools),
      - » inspect raw data,
      - » judge the quality of responses received,
      - » verify or negate automated advice
  - Vocabulary must be richer than the traditional feedback loop
  - Train to work as a partner; CRM

Use Training to Calibrate the Operator

- Train to predict what is coming next
- Trial and error learning
  - Humans prefer to learn novel device usage through exploration in the context of real tasks

Use Training to Calibrate the Operator

- Training must be adaptive
  - Skill level
- Issues such as remote sensing
  - Sensorimotor: Physical manipulation
  - repetitition leads to learning
- Train subtle cues
  - To learn what these cues are use GDTA, cognitive walkthroughs, verbal protocol analysis or response classification imaging
  - Train how to recognize the relevance of the cues and their effects on the existing plans
  - Train Attention
    - » literature indicates that attention to cues in field of view can be improved with repetitive training, showing a classic learning curve

Training alone is not sufficient

- Specialized interfaces
- Adaptive systems
  - Recurrent training
- Learning algorithms
- Human-robotic teaming

$$ on initial and recurrent training

- The right information is not provided, and it is not provided saliently
- Human-robot ≠ shared mental models
- Robot does not predictably react to human cues
- Standard nomenclature
- Robot is not socially intelligent
  - Comms interrupt primary task (can have neg effect on SA)
  - Particularly during

    planning (mission goal formation)

    evaluation (outcome interpretation and assessment)
- Tele-operation is better able to accommodate varying levels of autonomy and interaction
- Formal process to capture "Corporate Memory"
- Lessons unlearned without acc/inc database

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